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AIR-BORNE INFECTION[1]

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AN increasing awareness on the part of the medical profession of the rôle played by the air in the transmission of respiratory disease makes it seem appropriate just now to survey briefly the recent rapid growth of knowledge in this field. While it has been long known that bacteria can be carried on air currents, the general belief has grown up that certain physical agents such as sunlight, heat and drying are very effective in destroying such air-borne microorganisms. However, during the past few years our knowledge of the wide distribution of bacteria in the air has been greatly increased. Apparently the whole of our atmosphere is contaminated since microorganisms have been recovered from the stratosphere and from freshly fallen snow in the south polar regions.

[1] An address given before the Rochester Academy of Medicine, N. Y., October 6, 1942.

Some of the most striking evidence of aerial transmission of infection comes from the investigation of the spread of certain plant diseases. Epidemics of wheat-stem rust have been shown to be wind-borne from infected areas far distant. Spores of this infection have been found to be carried as much as 1,000 miles in 48 hours and cause an outbreak of the disease a week or ten days later. Similarly, plant viruses have been shown to be disseminated to some extent by wind, at least in an indirect manner, through the agency of leaf-hoppers and plant-lice.

While we have no evidence that any specific agent of human disease is spread through the outside air, except in the case of insect vectors, there is a growing body of data in support of the conclusion that air transmission within enclosed spaces plays an important rôle in the communication of many bacterial and

virus diseases, especially those of the respiratory tract. Before proceeding to a consideration of such evidence, I believe it would be of interest in view of our present military state, to review briefly the incidence of respiratory disease in the last war. Of the total number of 108,000 deaths in our armed forces during the period of April 1, 1917, to November, 1918, 50,000 were caused by battle casualties and 58,000 by disease —the usual higher rates of disease to battle casualty deaths, but a much smaller proportion than in previous wars. However, in contrast to other wars, respiratory disease accounted for 47,000 of the 58,000 or 80 per cent. of deaths due to disease in general. This high percentage of deaths from infection of the respiratory tract was of course due to the pandemic of influenza—the fatalities being caused principally by pneumonia. Of particular interest is the fact that probably the majority of the fatal pneumonias were associated with hemolytic streptococcus infection. An increase in the prevalence of the hemolytic streptococcus began with the measles epidemic in the army in the winter of 1917–1918 and when influenza arrived in 1918 the streptococcus was widespread.

The health of our armed forces during the first ten months of this war has been excellent. Respiratory disease, though mild, has however been very prevalent and has accounted for approximately half the total of all cases admitted to hospital for disease in general. While there have been very few deaths from respiratory tract infections, the amount of time lost from duty has been considerable. Surveys of hemolytic streptococcus carriers have revealed a much lower percentage than was present at a similar time during World War I, but among the soldiers suffering from acute infection of the respiratory tract these microorganisms are commonly found. Hence the hemolytic streptococcus presents a menace should the present type of respiratory disease become more severe or should an epidemic of influenza occur. Other pathogenic microorganisms, the pneumococcus, Pfeiffer's bacillus, hemolytic staphylococci, would, of course, play a rôle under such circumstances, but probably a less conspicuous one.

Evidence for Aerial Transmission of Infection

While the actual proof of infection occurring through air transmission is difficult to obtain except under experimental conditions either with animals or human volunteers, indirect evidence from clinical observation and bacteriological study is accumulating rapidly. Such instances of the spread of measles and chickenpox have been reported under conditions where direct and indirect contact has in all probability been excluded. Furthermore, the direction of the spread has frequently been shown to be that of the flow of the air currents. Wheeler and Duckett Jones[2] have recently reported an outbreak of highly fatal hemolytic streptococcal infection in a rheumatic fever hospital in which the infection spread from the lowest floor to the upper floors immediately above by way of the stairways where an upward air current was demonstrated. While no tests for air-borne bacteria were made at the time of the initial epidemic this was done later and the infecting types of hemolytic streptococci were recovered from the air of the stairways. An instance reported by White,[3] of what would appear to be aerial infection with dust-borne hemolytic streptococcus, was that of a ward attendant who having had no previous contact with this type of infection swept out a room which had been closed for five days following the discharge of a patient who suffered from streptococcal infection. Shortly thereafter the attendant developed an acute throat infection of the same type of hemolytic streptococcus as that producing disease in the patient.

An understanding of the manner in which air-borne infection can occur has been furthered greatly by the concept of droplet nuclei introduced by William Wells,[4] namely, that many small droplets expelled from the respiratory tract evaporate so rapidly that they float in the air for prolonged periods of time and ultimately settle in the dust of the room. Observations by a number of workers, English and Canadian in particular, have corroborated this idea of the manner of air contamination and have shown the importance of the rôle of dust and particulate matter from bed clothes, etc., in distributing pathogenic microorganisms through the air. A detailed account of some of these observations would be of interest, but time doesn't permit of more than a brief mention of some of the most striking findings. (Buchbinder[5] has given an excellent summary of this data in his recent review of the transmission of certain infections of respiratory origin.) Cruickshank[6] was the first to show that the rapid increase in the incidence of streptococcal infection of burns after coming into the hospital was due to cross infection from one or more cases carrying or infected with this microorganism. Furthermore, he was able to recover from the air of the ward considerable numbers of hemolytic streptococci of the same type as those causing the cross infections. Similar studies have been made by Allison and Brown[7] in scarlet fever wards where they found

[2] S. M. Wheeler and T. Duckett Jones, *Aerobiology*, Am. Assn. Advancement of Science Symposium, 17: 237, 1942. Also personal communication.
[3] E. White, *Lancet*, 1: 941, 1936.
[4] W. F. Wells, *Am. Jour. Hygiene*, 20: 611, 1934.
[5] L. Buchbinder, *Jour. Am. Med. Assn.*, 118: 718, 1942.
[6] R. Cruickshank, *Jour. Path. and Bact.*, 41: 367, 1935.
[7] V. D. Allison and W. A. Brown, *Jour. Hygiene*, 37: 11, 1937.

that complications and relapses in scarlet fever patients were due to reinfection with a type of hemolytic streptococcus other than that causing the primary infection. These reinfecting types were recovered from the air of the ward. Allison[8] has also made observations on the spread of streptococcic infection in a measles ward. The cross infections, due to the introduction into the ward of patients carrying the infecting types, occurred in individuals heretofore free from streptococci. Similar observations in diphtheria wards have revealed the presence of virulent diphtheria bacilli in the floor-dust and air at times when cross infections with these microorganisms were occurring.[9] A study by Miles[10] and associates of war wounds infected with streptococcus hemolyticus showed that they were cross infections from types of streptococci present in the air and the dust of the ward. Hare and Willits[11,12] have demonstrated the rôle played by dressings of streptococcal wounds and bed clothes of such patients in the aerial dispersal of hemolytic streptococci. Handling the dressings, especially dry ones, resulted in liberating considerable numbers of these microorganisms, which the authors were able to recover from the air by means of blood agar settling plates. Their finding that bed making of infected patients causes a marked increase in air contamination provides adequate reason for the advisability of isolating such cases.

Experimental studies on air-borne infection with certain pathogenic bacteria has yielded more conclusive evidence for this mode of transmission. Trillat[13,14] showed many years ago that experimental infection of small animals with paratyphoid or fowl cholera bacilli could be accomplished by exposing them to atmospheres containing a finely atomized mist of cultures of these microorganisms. Wells and Lurie[15] found that pulmonary tuberculosis in rabbits could be produced by placing these animals in a chamber into which cultures of tubercle bacilli had been sprayed. Studies on air-borne pneumococci, on the other hand, have yielded little evidence that pneumonia in normal animals is acquired simply by inhalation of pneumococcus-containing droplets. However, if the animals' resistance is lowered by alcoholization, as shown by Stillman and Branch,[16] or if it is suffering from experimental influenzal infection as first demonstrated by Smorodintseff and co-workers,[17] inhalation of pneumococcus-containing atmospheres will result in pneumococcal infection of the lungs.

Another disease whose dispersal has been suspected to occur by way of the air, but in which evidence of aerial transmission has been lacking until recently, is influenza. Repeated attempts made in 1918 to transmit to human volunteers the pandemic influenza, failed. It was not until 1937 that a group of Russian workers headed by Smorodintseff[18] succeeded in producing influenza in human volunteers by allowing them to inhale influenza virus dispersed in fine droplets in the air. Since then aerial transmission of influenza in ferrets has been accomplished.[19,20] More recently, Smorodintseff,[17] Wells and Henle[21] and our laboratory[22] have been able to produce experimental influenza in mice by the air-borne route. The virus employed, having been passed through several hundred mice following its isolation from a human case, was atomized as a very fine mist into a chamber containing the mice to be infected. We found that an exposure of only 15 seconds to an amount of virus diluted 300,000 times in the chamber air sufficed to produce pneumonic lesions in all the mice. A two-minute exposure resulted in death of all the animals. Even with amounts of virus corresponding to a dilution in the air of one to thirty million, all the mice acquired pulmonary lesions. That influenza virus may remain suspended in air in a viable and infective state for relatively long periods of time was demonstrated by introducing mice into virus-containing atmospheres as long as three hours subsequent to atomization of the virus. All the mice became infected.

It seems likely that the virus of the common cold may also be communicated through the air, but of this we have no proof. Neither do we have any information as to the mode of transmission of the newly recognized acute pulmonary disease which has been designated as primary atypical pneumonia. However, one disease, whose communicability through the air had not been heretofore seriously considered, namely, poliomyelitis has recently been transmitted experimentally by the air-borne route.[23]

CONTROL OF AIR-BORNE INFECTION

Measures available and which are now being advocated for the control of air-borne infection fall into

[8] V. D. Allison, *Lancet*, 1: 1067, 1938.
[9] W. E. Cristie and H. D. Wright, *Lancet*, 1: 656, 1941.
[10] A. A. Miles *et al.*, *Brit. Med. Jour.*, II: 855, 895, 1940.
[11] R. Hare and R. E. Willits, *Canad. Med. Assn. Jour.*, 44: 230, 1941.
[12] R. E. Willits and R. Hare, *Ibid.*, 45: 479, 1942.
[13] A. Trillat and R. Kaneko, *Comp. Rend. Acad. de Sci.*, 173: 109, 1921.
[14] A. Trillat, *Ibid.*, 194: 321, 1932.
[15] W. F. Wells and M. B. Lurie, *Am. Jour. Hygiene*, Sect. B, 34: 21, 1941.
[16] E. G. Stillman and A. Branch, *Jour. Exp. Med.*, 40: 733, 1924.
[17] A. A. Smorodintseff *et al.*, *Arkhiv. biologicheskekh Nauk*, V. 52, No. 1, 1938.
[18] A. A. Smorodintseff *et al.*, *Am. Jour. Med. Sci.*, 194: 159, 1937.
[19] A. Trillat, *Comp. Rend. Acad. de Sci.*, 205: 1186, 1937.
[20] C. H. Andrews and R. E. Glover, *Brit. Jour. Exp. Path.*, 22: 91, 1941.
[21] W. F. Wells and W. Henle, *Proc. Soc. Exp. Biol. and Med.*, 48: 298, 1941.
[22] C. G. Loosli, O. H. Robertson and T. T. Puck, *Jour. Inf. Dis.* In press.
[23] H. K. Faber and R. S. Silverberg, SCIENCE, 94: 567, 1941.

two categories—those designed to prevent dispersal of infectious material into the air and those employed or proposed for reducing the infectivity of already contaminated atmospheres, by killing or removing the disease-producing agents.

It has been shown that pathogenic microorganisms —such as the hemolytic streptococcus and pneumococcus—may remain suspended in the air for many hours or days and that their virulence after several weeks' sojourn in the dried state in dust is unimpaired. Buchbinder's[24] observations are especially informative in this respect. Since air currents redistribute the bacteria which have settled in the dust, control of dust has become an important consideration in preventing air contamination. Experiments of Van den Ende[25] and Thomas[26] have demonstrated that the bacterial content of the air of wards or patients' rooms may be greatly reduced by oiling the floors and sweeping with oiled or moistened brooms. Furthermore, they and others have found that treating blankets with a diluted light mineral oil is most effective in preventing distribution of bacteria from the bed clothes. Employing both these measures resulted in a reduction of more than 90 per cent. of air-borne bacteria.

The most important preventive measure is the isolation of the infected patient. This is most effective when single-room isolation is employed. Ward isolation, *e.g.*, segregation of patients suffering from the same communicable disease, is of course much less costly and under certain conditions the only feasible measure, but the grouping of patients with such diseases as measles, scarlet fever or influenza presents the hazard of cross infection of various kinds. For example, scarlet fever patients hospitalized in separate rooms rarely acquire types of hemolytic streptococcus other than that producing the infection, whereas those placed in wards commonly become reinfected with new types and show a much higher incidence of complications. Barriers between the beds and adequate spacing of patients undoubtedly diminish the direct transfer of infected droplets from patient to patient but appear to have little effect in preventing the distribution of dried or dust-borne bacteria.

Another measure for preventing dispersal of bacteria and viruses into the air is adequate masking. I use the word "adequate" advisedly since most of the masks employed in hospitals are relatively ineffective. Jennison's[27] stroboscopic photographs have afforded striking demonstration of air contamination by sneezing and coughing especially by persons suffering from colds, and the effect of proper masking of such individuals. The Canton flannel mask devised by McKhann[28] has been found to be a highly effective and practical one. The relative impermeability of this type of mask even under the great pressure of a sneeze provides good evidence for its effectiveness in preventing the inspiration of infective droplets.

While the institution of such measures provide a good ground-work for the control of air-borne infection and may under certain favorable conditions be adequate, there still remains the need for reducing the infectivity of contaminated atmospheres. This applies especially to conditions in times of war, under which isolation of infectious patients may be difficult or impossible, and other procedures of preventing air contamination, including continuous masking of ward personnel, becomes impractical. It seems likely that air-borne infection of both bacteria and virus origin depends on the concentration of the infectious agent in the atmosphere. Wells's studies have brought out this point and our own results on experimental transmission of influenza to mice, as well as the observations of others, lend support to this conclusion. If the concentration of the pathogenic material in the air can be kept below a certain critical level, infection only seldom occurs, *i.e.*, the dosage of inhaled pathogens is not sufficient to cause disease—although infection may occur if the dosage is increased by prolonged inhalation of even a small concentration of the infectious agent. Thus any measure which will sufficiently lower the concentration of an air-borne infectious agent should be effective in reducing or eliminating infection. The means which has been most commonly employed for this purpose is ventilation. If a sufficient number of air changes per hour can be secured, the building up of a high concentration of any infectious agent can be prevented. Reyniers[29] has made use of filtered outside air flowing through a system of complete mechanical barriers—consisting of a primary chamber containing the patient and a secondary one connecting with the corridor. While this installation is effective in protecting the patient completely against infection by attendants and bacteria-containing air in the corridor or ward, it is too complicated for use in the average hospital.

Effect of Ultraviolet Radiation

The bactericidal effect of light has been shown by Buchbinder[5] to be surprisingly effective. Sunlight most of all, but diffused daylight from a blue sky killed 50 per cent. of streptococci and pneumococci

[24] L. Buchbinder, M. Solowey and M. Solotororsky, *Jour. Bact.*, 42: 615, 1941.
[25] M. Van den Ende, D. Lush and D. G. Edwards, *Lancet*, II: 133, 1940.
[26] J. C. Thomas and M. Van den Ende, *Brit. Med. Jour.*, I: 953, 1941.
[27] M. W. Jennison, "Aerobiology," Am. Asn. Adv. Sci. Symposium, 17: 106, 1942.
[28] W. McKhann, data to be published.
[29] J. A. Reyniers, "Aerobiology," Am. Asn. Adv. Sci. Symposium, 17: 254, 1942.

in three quarters of an hour. Hence large window space is most desirable for hospitals. The most potent light effect is that from the ultraviolet end of the spectrum, and the use of specially constructed lamps for the purpose of air-sterilization has now been the subject of study for a number of years. The development of this field has been due principally to Wells[30] and while the number of well-controlled observations on the value of ultraviolet radiation in the control of the spread of air-borne infection is as yet limited, evidence is being accumulated to show that under certain conditions and in certain types of disease ultraviolet radiation is effective. I will mention briefly several studies which seem to demonstrate that the use of germicidal lamps has reduced strikingly the incidence and spread of air-borne infection. One was made by Hart[31] at the Duke University Hospital. For some reason, possibly due to the peculiar locality or the kind of upper respiratory tract flora of the operating room personnel, their incidence of post-operative infection was alarmingly high. Hart made a bacteriological study of the air of the operating rooms and the throats of the surgeons and nurses and found pathogenic bacteria, especially hemolytic staphylococci, very prevalent. He then had ultraviolet lamps installed above the operating tables so that the whole operative field was irradiated. Very promptly the occurrence of post-operative infection was greatly reduced and this was accompanied by a marked diminution in the number of bacteria in the air of the operating room.

A second study has been made at the Cradle in Evanston by Sauer, Minsk and Rosenstern.[32] One ward in this institution was equipped with ultraviolet lights arranged in such a way that each infant's cubicle is protected against the rest of the occupants of the ward by means of a so-called curtain of radiation, *i.e.*, the lamps are placed over the open entrance of the cubicle and throw a screen of light to the floor. During the winter of 1940–41, one of the infants in the control ward contracted a cold. This ward was simply air-conditioned. Within a month or six weeks, the respiratory infection spread throughout the entire ward, affecting every one of the 12 infants. However, in the radiated ward not a single cold occurred despite the fact that some of the nurses in the ward contracted colds during this period. A third ward with doubly partitioned chambers built on the principle of Reynier's mechanical barrier showed only one infection.

A striking instance of the control of chicken-pox with ultraviolet radiation has been reported by Barenberg and associates.[33] In an institution housing 165 infants and children, 97 per cent. developed chicken-pox while not one of the children in the irradiated ward contracted the disease. A recent study of Wells, Wells and Wilder,[34] provides evidence for the control of measles and mumps by means of germicidal lamps installed in schoolrooms. This study, which extended over a five-year period and included observations on a large number of children in three schools, showed that the incidence of measles, in particular, in the irradiated classrooms was very much lower than that occurring among the pupils in the non-irradiated rooms.

The limitations on the use of this form of air-sterilization are that the persons in the irradiated rooms must be shielded from the light which has the sun-burning effect of bright sunlight. This means that in situations other than the special one described in the Cradle installation, it is possible to irradiate only the air above the head. While under these circumstances bacteria and viruses in the upper air of the room can be killed, control of the contaminated lower air depends on air currents which will carry the infected droplets or dust particles up into the stratum of germicidal light. Under certain conditions such partial sterilization of the air may be adequate as pointed out earlier but in other cases more complete killing of air-borne infectious agents may be required. Furthermore, dust-borne bacteria are more resistant to the light than are bacteria carried in droplets. Ultraviolet light is now being employed in a number of different kinds of environments and data should be forthcoming as to its general effectiveness and limitations.

Chemical Air Sterilization

Another method of air-sterilization which has been recently introduced is that of disinfection of the air by chemical means. While the idea of employing bactericidal mists as a method for controlling air-borne infection dates from Lister's original use of phenol sprays in preventing wound infections in operating rooms, until recently no one had succeeded in producing by this method a sterile or relatively bacteria-free atmosphere which could be tolerated by human beings. During the past few years new means of chemical air-sterilization have been devised. These consist in the dispersal of germicidal mists containing the effective chemical agents in such small amounts as to be non-detectable or at least unobjectionable to persons in the treated atmosphere. The compounds

[30] W. F. Wells and M. W. Wells, *Jour. Am. Med. Asn.*, 107: 1698, 1936.
[31] D. Hart, *Jour. Thoracic Surg.*, 6: 45, 1936.
[32] L. W. Sauer, L. D. Minsk and L. Rosenstern, *Jour. Am. Med. Asn.*, 118: 1271, 1942.
[33] L. H. Barenberg, D. Green, L. Greenopan and B. Greenberg, "Aerobiology," Am. Asn. Adv. Sci. Symposium, 17: 223, 1942.
[34] W. F. Wells, M. W. Wells and T. S. Wilder, *Am. Jour. Hygiene*, 17: 254, 1941.

employed for this purpose are believed to be non-toxic in the minute amounts present in the inspired air.

The initial report on this new approach to the control of air contamination was made by Douglas, Hill and Smith in 1928.[35] They employed a fine spray of a solution of NaOCl and found that in concentrations of one gram of the solution in two million cc of air—complete killing of *B. coli* dispersed in the air could be effected. However, it was not until ten years later that active development of the subject began. In 1938 two papers appeared, one by Trillat[36] concerning the properties of germicidal aerosols—liquid aerosols consist of droplets 1–2 microns in diameter dispersed in air—and the other paper by Mastermann[37] on air-sterilization by atomizing NaOCl solutions. Trillat found that certain germicidal agents which killed bacteria in the test-tube in dilutions not higher than 1:200, were capable of causing death of air-borne bacteria when dispersed in aerosol form in concentrations of one gram of the chemical substance in 5 million cc of air. He believed that the bactericidal activity was due to direct interactions between aerosol droplets and bacterial particles. Mastermann, on the other hand, believed that the high bactericidal effect of NaOCl—he obtained killing effects on air-suspended bacteria in concentrations of one gram of NaOCl in 40 million cc of air—was due to the liberation of HOCl gas from the NaOCl mist and was not an aerosol effect. In the next two or three years, studies by several groups of English workers confirmed and extended Trillat's and Mastermann's observations. Twort and associates[38] employed an aerosol consisting of hexyl resorcinol dissolved in propylene glycol and reported bactericidal effects on certain non-pathogenic microorganisms with extraordinarily small amounts of this material—as little as one gram in four billion cc of air. Pulvertaft and Walker[39] used resorcinol in glycol as well as NaOCl and found both these effective in killing pathogens of the respiratory tract. Andrewes[40] found that influenza virus was susceptible to the lethal effect of these germicidal mists.

Our studies in this field consisted initially in the search for a substance which would fulfil most nearly the requirements for an ideal air-sterilizing agent, namely, that it be non-toxic, non-irritating to the respiratory tract, odorless, tasteless and yet possess a marked and rapid killing action on bacteria suspended in air. Furthermore, it should be relatively inexpensive and easily obtainable. Among the compounds tested which included a number of glycols, it was found that propylene glycol most nearly fulfilled these requirements.[41] This compound, a dihydric alcohol, is closely related to glycerine and has the formula $C_3H_6(OH)_2$.

Studies on the air-sterilizing activity of propylene glycol, which are still in the experimental stage, have shown that this substance, when dispersed as an aerosol or in vapor form, produced rapid killing of large numbers of air-borne bacteria. Pathogenic bacteria of the respiratory tract, pneumococci, hemolytic streptococci and staphylococci, *H. Influenzae* and *H. Pertussis,* were killed immediately when sprayed into atmospheres containing concentrations of one gram of propylene glycol in two to four million cubic centimeters of air. Lesser concentrations of the glycol exerted an immediate and pronounced bactericidal effect although a certain interval of time was required for complete sterilization of the air. Dried bacteria were also shown to be susceptible to the lethal action of the glycol. Adequate controls have been carried out to show that this is a bactericidal and not simply a bacteriostatic effect. Killing of the virus of influenza A was demonstrated by tests in which mice placed in an atmosphere of propylene glycol vapor were found to be protected completely against infection with amounts of air-borne influenza virus that produced death regularly in the control animals.[42]

Knowledge concerning the mechanism of the bactericidal effect of propylene glycol on air-suspended bacteria is still incomplete. However, it has been possible to acquire certain information which has provided the basis for a tentative explanation of the initial phase of this process. It was found that propylene glycol possesses a relatively low germicidal action *in vitro.* Certain bacteria such as the pneumococcus and staphylococcus grow well in broth containing 5 to 15 per cent. of the glycol, but if these microorganisms are suspended in 80 to 90 per cent. propylene glycol they are killed immediately. The means by which a mist of this glycol can produce a lethal concentration in the immediate environment of the bacteria would seem to be limited to two possibilities: (a) direct contact between the glycol droplets and bacterial particles; (b) the production of sufficient vapor or gas by evaporation of the glycol droplets to permit rapid and abundant collision of gas molecules with the bacterial particles. Calculations of the maximum number of contacts between aerosol and bacterial droplets indicate that it would take between 2 and 200 hours for sterilization to occur if this were the mode

[35] S. R. Douglas, L. Hill and W. Smith, *Jour. Indust. Hygiene,* 10: 219, 1928.
[36] A. Trillat, *Bull, de l'Acad. Med.,* 3 Sc. 119: 64, 1938.
[37] A. T. Mastermann, *Jour. Indust. Hygiene and Toxicity,* 20: 278, 1938.
[38] C. C. Twort, A. H. Baker, S. R. Finn and E. O. Purcell, *Jour. Hygiene,* 40: 253, 1940.
[39] R. J. V. Pulvertaft and J. W. Walker, *Jour. Hygiene,* 39: 696, 1939.
[40] C. H. Andrewes *et al., Lancet,* 2: 770, 1940.
[41] O. H. Robertson, E. Bigg, T. T. Puck, B. F. Miller, *Jour. Exp. Med.,* 75: 593, 1942.
[42] O. H. Robertson, C. G. Loosli, T. T. Puck, E. Bigg and B. F. Miller, SCIENCE, 94: 612, 1941.

of action. The exceedingly rapid bactericidal action which we have observed could be accounted for only if the glycol were present in the gas phase. Since propylene glycol is a highly hygroscopic substance rapid absorption of glycol gas by fluid droplets might be expected to occur. Indeed calculations show that with vapor concentrations even below the saturation values of propylene glycol the number of collisions between gas molecules and droplets containing bacteria is sufficient to produce almost instantly a lethal concentration (up to 80 per cent.) of propylene glycol in the droplets. Furthermore, the observed rate of evaporation of droplets of a propylene glycol mist is so rapid that a relatively high vapor concentration is liberated within a second or two. The problem as to how the glycol, once having achieved the effective concentration in the bacterial droplet, kills the microorganisms has not been elucidated.

Before practical application of this method of air-sterilization by germicidal mists and vapors can be instituted, the conditions under which they are most effective should be clearly understood and conclusive evidence of the harmlessness of breathing such chemically treated atmospheres must be secured. That the degree of relative humidity has a marked influence on germicidal action has been recognized by Baker and Twort[43] in the use of their aerosols and has also been found by us in the study of propylene glycol vapor. These air-sterilizing agents are most effective at relative humidities of 40 to 60 per cent. Our studies have shown that the amount of propylene glycol vapor which can be held in the air is inversely proportional to the relative humidity, thus increasing the humidity above the medium range results in a progressive diminution in the concentration of glycol vapor in the air and hence a diminished bactericidal effectiveness. On the other hand, the lessened activity of the glycol vapor in dry atmospheres, even though the vapor is present in relatively high concentrations, may be attributed to rapid desiccation of the bacterial droplets which diminishes their affinity for propylene glycol molecules. We found that temperature also affects this process. Increasing the temperature from 15° to 35° C results in a progressive decrease in bactericidal action.[44]

Other important problems which require elucidation are: (1) the most efficient means of dispersing the chemical agents into the air; (2) the manner in which they can be evenly distributed throughout an enclosed air space; (3) determination of the concentrations desirable and obtainable under varying conditions of ventilation; (4) tests for purity of different lots of propylene glycol or other agents. These problems are being studied.

The question of possible toxic effects from breathing atmospheres containing chemical compounds can be answered only by long-term observations on appropriate animals. There are considerable data in the literature on the toxicity of propylene glycol when administered orally or injected intravenously. Prolonged feeding experiments by a number of workers have shown that rats fed relatively large amounts of propylene glycol for periods of six months to two years apparently suffered no ill effects. Intravenous injection of this substance has shown that it is less toxic than ethyl alcohol. The low toxicity of propylene glycol is quite probably due to the fact that it is metabolized in the body.

We have exposed rats to this glycol in vapor form continuously for a period of 15 months. These animals have shown no ill effects from their sojourn in such an atmosphere and microscopic examination of the lungs and other organs of the body has revealed no changes not seen in similarly aging normal rats. While this is good presumptive evidence for the harmlessness of propylene glycol, we have felt that adequate information on this important point can be obtained only in an animal corresponding more closely to the human being in posture and lung structure. Both clinical and experimental observations indicate that foreign material is eliminated from the lungs of non-erect animals much more readily than it is from those species maintaining a more or less erect posture. Although propylene glycol is readily soluble in the body fluids and would probably be absorbed from the lung, it is possible that accumulation might occur in the lungs of man while an equivalent quantity would be adequately eliminated from the respiratory tract of the rat. Furthermore, we have found that small amounts, one fourth to one half cc of propylene glycol in liquid form, injected directly down the trachea of a rat, produces marked irritation leading to abscess formation and fibrosis. Hence, we have instituted a long-term test in exposing monkeys to propylene glycol atmospheres.

Thus far, little data are available on the practical use of germicidal mists and vapors. This means for controlling air-borne infection has been used to some extent in England, but almost nothing has been published on the results. A brief preliminary report by Harris and Stokes[45] on the effect of propylene glycol vapor in reducing acute respiratory infection in a children's ward suggests that it may be effective.

It would seem probable that the different measures

[43] A. H. Baker and C. C. Twort, *Jour. Hygiene*, 41: 117, 1941.

[44] Unpublished experiments.

[45] T. H. Harris and J. Stokes, Jr., *Am. Jour. Med. Sci.*, 204: 430, 1942.

employed or proposed for the control of air-borne infection, *e.g.*, isolation, masking, dust control, ventilation, ultraviolet radiation and chemical air sterilization, would all prove useful either alone or in combination depending on the particular conditions and the purposes for which they are employed. Extended observations under well-controlled conditions will be required to determine the relative effectiveness of these methods. A study of this nature is now being conducted in an army hospital by the Commission on Cross Infection in Hospitals[46] under the direction of the Surgeon General of the U. S. Army.

OBITUARY

LUDWIG KALLIR

LUDWIG KALLIR, retired chairman of the board of directors and chief engineer of the A.E.G. Union Electric and Manufacturing Company, Vienna, Austria, died on January 7, 1943, in a London, England, hospital. He was 68 years of age. Mr. Kallir had been prominently identified with power generation, transmission and distribution in Central Europe for more than forty years. He was a member of the committee of action of the International Electrical Commission and the chairman of the committee for standard specifications of the Austrian Institute of Electrical Engineers. He represented his country at many international conferences as an official delegate; as such he spent some time in this country during the 1936 World Power Conference. Best known among his many papers and articles in the technical press and in the transactions of engineering societies was his contribution on "Power Transmission" in the well-known European handbook on electrical power edited by Rziha and Seidener.

Born in Austria in 1874, he received his engineering education at the Vienna Institute of Technology and graduated in 1896 with highest honors, and stayed there for the following four years as an instructor in electrical engineering until he joined the Union Electric and Manufacturing Company, Vienna, which was later bought by the A E G Berlin and became as their Austrian branch the A.E.G. Union Electric and Manufacturing Company. In 1908 he was assigned the duties of head of the central station engineering department. Later he became a member of the board of directors, finally its chairman and chief engineer of the company. He retired in 1937 and kept on in Vienna in a consulting capacity until German influence began to overrule first the economic and then the political life of his native country; however, there was no place for an upright man of his kind after the annexation of Austria and he went to England in 1939, where the British Electrical and Allied Industries Research Association, London, gave him an opportunity to keep on in his lifelong devotion to electrical engineering.

The outstanding qualities of Mr. Kallir as an engineer were matched by a charming personality and a deeply humane attitude towards those serving under and with him. Among many other honors which he received was his election as a member of the committee of action of the International Electrical Commission, and his appointments as an honorary consultant to the Austrian Department of the Interior and to the Board of Examiners of the Vienna Institute of Technology. He was a member of the American Institute of Electrical Engineers, the Institution of Electrical Engineers (London), the Swiss Institute of Electrical Engineers, the International Conference on Large High Voltage Systems (Cigré) in Paris, the Austrian Illuminating Society and a former president of the Austrian Committee of the International Electrical Commission and of the Austrian Institute of Electrical Engineers.

ERIC T. B. GROSS
CORNELL UNIVERSITY

HARRY L. DEMBER

DR. HARRY L. DEMBER was born at Leimbach, Germany, on July 11, 1882. Educated at the Universities of Göttingen and Berlin, he was appointed privatdozent at the Technische Hochschule, Dresden, in 1909. In 1914 he was appointed associate professor under Hallwachs. During the same year he was selected by the United German Academies to head a research group for studies in atmospheric optics and atmospheric electricity on Teneriffe.

Upon the death of Professor Hallwachs in 1923 he became professor and dean of the mathematics and physics faculty. When Hitler came to power in 1933 Dr. Dember was retired and awarded a government pension but was told not to enter the physics laboratory. However, in the same year a call came from the government of Turkey to head the department of physics in the University of Istanbul, which he accepted.

In 1941 he decided to come to America, where a daughter and a son had been in residence for some years. After a very long and difficult trip of about 15,000 miles via New Delhi and Cape of Good Hope, he and Mrs. Dember arrived in New York in November, 1941. He came to Rutgers University on January

[46] Board for the Investigation and Control of Influenza and other Epidemic Diseases in the Army, Preventive Medicine Division, Office of the Surgeon General, United States Army.

29, 1942, on a lectureship in physics. Later he was appointed visiting professor of physics. He passed away very suddenly on March 22, 1943. He fitted into the American university life and procedure astonishingly well considering his training and experience in Europe. He was very well liked by his students and associates. He was just about to publish a paper on photoconductivity of crystals. Throughout a very active life he has published some fifty or sixty papers, mainly in photoelectricity, canal- and x-rays. He will be missed very much both in teaching and research.

GEORGE WINCHESTER
RUTGERS UNIVERSITY

MINNIE TAYLOR YORK

To her many friends the sudden death of Mrs. York came as a great shock. As junior pathologist in the U. S. Department of Agriculture from 1913 to 1923 and as librarian of the Cleveland Museum of Natural History from 1924 to 1934 she had had the admiration and respect of all with whom she worked. Never willing to compromise with what was less than best, she possessed a remarkable sense of fairness in all of life's relationships. In spite of her professional duties and later her club activities and home responsibilities, she always found time for those unrequired details of kindness which bespeak a noble character. Many readers of SCIENCE knew Mrs. York as capable scientist, as gracious hostess and as friend. All such extend their sympathy to her husband and her mother.

W. G. HUTCHINSON
UNIVERSITY OF PENNSYLVANIA

RECENT DEATHS

DR. HAMILTON PERKINS CADY, professor of chemistry and chairman of the department at the University of Kansas, died on May 26 at the age of sixty-eight years. He had been a member of the faculty for forty-four years.

HAZEL C. CAMERON, research associate in nutrition in the Agricultural Experiment Station of West Virginia University, died on May 6 at the age of fifty-three years.

SCIENTIFIC EVENTS

THE AMERICAN CHEMICAL SOCIETY AND THE WAR MANPOWER COMMISSION

AT a meeting in Detroit on April 11 of the Board of Directors of the American Chemical Society, it was moved, seconded and carried unanimously that the letter of April 1, 1943, from Secretary Charles S. Parsons to H. T. Briscoe, of the War Manpower Commission, be approved and the board instructed the secretary to do all in his power to put the policy into effect.

In the letter which is printed in *Chemical and Engineering News* Dr. Parsons emphasizes the fact that the society is, and always will be, ready to serve the War Manpower Commission in any way it can be useful. Its function in this effort, however, is confined to the proper assignment and utilization of chemists and chemical engineers. He continues:

> Electrical, mechanical, civil, sanitary and radio engineers, physicists, mathematicians and other groups of specialists are needed in both the combat and production armies. Except in a few specific instances, already overstaffed, chemists and chemical engineers have no utility as such in the combat forces.

Clearly foreseeing the situation and probable emergency, the American Chemical Society through its officially constituted defense committee met with General Hershey in December of 1940 and carefully considered the problem that faced the country. The American Chemical Society's committee on national defense consists of Roger Adams, dean of chemistry at the University of Illinois, *Chairman;* James B. Conant, president of Harvard University; Warren K. Lewis, head of the department of chemical engineering at the Massachusetts Institute of Technology; Thomas Midgley, Jr., vice-president of the Ethyl Corporation and chairman of the board of directors of the American Chemical Society; Edward R. Weidlein, director of the Mellon Institute and (at that time) chairman of the Chemicals and Allied Products Division of the War Production Board; Robert E. Wilson, president of the Pan American Petroleum and Transport Company; and myself, secretary of the society.

At that and subsequent conferences a general plan of procedure was formulated in accord with the major premises already outlined and, through its publications, its national and sectional meetings and by thousands of letters and other direct communications, the American Chemical Society has done all in its power to enlighten the profession, the industry, the public and the local, appeal and state boards of the true situation and its importance to the war effort. In this campaign the society has been supported, seconded and assisted by General Hershey and his able staff. Local and appeal boards and state directors have been informed through occupational bulletins and other so-called directives that chemists and chemical engineers should be deferred where utilized in the war effort or in training others therefor. Unfortunately, Selective Service can only advise and has no authority to order. In spite of all efforts, as previously stated, approximately 5 per cent. of the chemists and chemical engineers of the country are in the Army or the Navy serving ably but not in a chemical capacity. However, it is no small accomplishment that approximately 95 per cent. of those subject to the draft are serving to-day in the Production Army. Retention of this high per-

centage is due in a large measure to the educational campaign conducted by the American Chemical Society with the active cooperation of the Selective Service System constituted by law for such purposes, as its name implies.

Having outlined the problem and recorded two and one-half years of experience, I can reply now to the questions you have propounded.

If your suggested committee is to handle and give advice regarding the classification of chemists and chemical engineers, essentially the same as the committee which has been formed to advise in cases of physicists (Local Board Release 159), the American Chemical Society is prepared to function. We can readily present to you suggestions for its make-up from among the best chemists and chemical engineers in America—men who will serve without compensation from the War Manpower Commission or from the Government.

However, if it is the War Manpower Commission's proposal to form a committee of heterogeneous "engineers" to function for all "engineers," including those specifically trained chemically, we prefer to continue to serve America and the country's qualified chemical engineers as we have been doing. We do not believe that a heterogeneous committee of electrical, mechanical, civil, radio, sanitary and other engineers can hope to envision the problems of the chemical industry or those of the chemical engineers themselves, as could a committee composed of members of the chemical profession; nor do we believe that the War Manpower Commission or Selective Service itself would have equal confidence in its findings.

THE COPERNICAN QUADRICENTENNIAL

AT the celebration in New York City on May 24 of the four hundredth anniversary of the death of Copernicus, messages were read from President Roosevelt and the President of Poland, Wladyslaw Raczkiewicz, now in London. Copernican citations were conferred upon a group of pioneers in science and civilization, nine of whom were Americans and one Chinese.

President Roosevelt's message was read by Professor Harlow Shapley. The President wrote:

> Not only must great men and great nations be allowed to attain freedom. Liberty must be made progressively available to small states, to communities, and to the individual himself if humanity is to march forward into light and life. We must always remember that the creation and sweep of great liberalizing ideas may be the work of a single isolated individual, as in the case of Copernicus.

Dr. James Rowland Angell, president-emeritus of Yale University, was chairman of the committee on citations. Those honored with citations were:

Dr. John Dewey, "who has stimulated and enriched the thinking of his time in education, philosophy and in all arts of life."

Walter (Walt) Disney, "whose animated cartoons have delighted audiences the world over."

Professor Albert Einstein, "whose revolutionary concept of space, time and energy has transformed both science and philosophy."

Henry Ford, "for opening a new horizon to manufacture."

Dr. Ernest O. Lawrence, of the University of California at Berkeley, "inventor and builder of the most powerful engine of transmutation of the elements."

Dr. Thomas Hunt Morgan, of the California Institute of Technology, "author of a revolution in our knowledge of the causes and mechanisms of inheritance."

Igore I. Sikorsky, "pioneer aeronautical engineer who has created a helicopter of revolutionary implications."

Dr. Wendell M. Stanley, of the Rockefeller Institute at Princeton, N. J., "discoverer of a crystalline protein having all the characteristics of disease-producing virus, a concept revolutionary for the study and control of virus disease."

Orville Wright, "who fashioned wings for man and showed him how to navigate the ocean of the air."

Dr. James Y. C. Yen, of Chungking, who invented "a simple, easily mastered system of written Chinese whereby the book of knowledge has been opened to millions of previously illiterate minds."

PRESENTATION OF THE FIRST CHARLES L. MAYER AWARD

PRESENTATION of the first Charles L. Mayer Award of $2,000 was made to Dr. Charles Huggins at the annual dinner meeting of the Board of Directors of the National Science Fund of the National Academy of Sciences, which was given on May 19 at the University Club, New York City. Dr. William J. Robbins, chairman of the fund, presided at the dinner and, following the citation for the award made by Dr. Peyton Rous, Dr. Frank B. Jewett, president of the National Academy of Sciences and a director of the fund, presented the award to Dr. Huggins. The citation reads:

> The work for which Dr. Huggins is to receive the first Charles L. Mayer Award makes possible the alleviation of cancer of the human prostate in a large proportion of instances, with perhaps a permanent control in some cases. But its implications are more than practical; they stress a principle which has been little regarded. In searching for means to combat cancer most workers strive to exploit the difference of tumor cells from normal ones, and sometimes with success, as in the treatment of cancers of the skin by Roentgen rays, the tumor cells succumbing to exposures which healthy elements survive. Dr. Huggins has proceeded in the diametrically opposite way; he has played upon what is normal in the malignant cells, the remaining good in them as one might say, and they have responded. This response is a fact which reveals. Hence, with your permission, I will speak briefly concerning it. And with apologies to Dr. Huggins, for there are few occasions which put a scientist more justifiably on tenterhooks than when another attempts in his presence to point to the place in nature of his discoveries.

Research workers found out a long while ago that they could induce cancers to appear in animals by irritating the tissues with various physical or chemical agents. The agents which do this, the carcinogens, call forth benign growths as well, tumors doing no harm other than that which may result from their bulk. And they not only bring cancers into being which are capable of slaying the host but others which need aid if they are to progress and which, in the lack of it—as when the carcinogen is discontinued—dwindle and vanish. The occurrence of such hesitant cancers, forced upon the organism under the exaggerated conditions of experiment, was first noted in 1915; but almost no attention has been paid to them for the reason that in human beings one seldom sees them, or rather, seldom perceives them for what they are. The growths which drive people to seek medical attention have already been tried out by circumstances, they are the fit which have emerged, they are going concerns. Yet if pathologists had only searched they might long ago have seen that the prostates of many men over forty contain tentative cancers, which come to nothing as statistics show, being still microscopic nodules in old age. It is the exceptional prostatic cancer which extends beyond the capsule of the organ. All this is very recent knowledge.

The gross differences in the behavior of human cancers, including the prostatic, are of course merely the expression of difference in cell capability and form. Cancer cells are popularly supposed to be in a state of anarchy, but this is seldom the actual case. Nearly always they are more like delinquents which make attempts in their poor way to carry out the accustomed tasks of entities of their sort. Some of those arising from glands deviate so little from the normal as still to produce secretions in line of duty, and often they build glandular structures as they proliferate, though crazy structures to be sure. More important in the present relation, they respond in greater or less degree to the influences affecting normal cells. Only in extreme instances do they wholly disregard the laws of organism. Most tumor cells appear to do the best they can with their disturbed abilities, differentiating and functioning so far as their abnormal state will let them and the urge that is on them to multiply.

It was upon these facts that Dr. Huggins acted. He was aware, partly through his own researches, that the activities of normal prostatic cells are maintained by the male sex hormones, substances elaborated in the testicles. What he attempted was to learn whether any prostatic cancers are still sufficiently like normal gland tissues to undergo involution with the latter when the stimulation by hormones is withdrawn. Putting aside the assertions of the text-books that castration had no useful effects in such respect he removed the testes of patients with hopeless prostatic cancers, after obtaining their consent. Dramatic happiness followed of which he will tell you.[1] They throw a far light.

That Dr. Huggins should be a surgeon is one of the happy circumstances of his achievement. Surgeons of all men have most direct access to tumors—I do not mean to play on words—yet it is their sardonic fate to have to employ their energies mostly in taking growths out, not in reasoning why as concerns them. Dr. Huggins, like the great surgeons of the past, has proved stronger than the demands of his vocations, and most rewardingly has he reasoned.

There is no natural phenomenon which challenges scientists in a more peremptory way than cancer. To layman and scientist alike it will seem fitting that the first prize administered by the National Science Fund, the Charles L. Mayer Award, should have been offered for "a contribution to our knowledge of factors affecting the growth of animal cells, with particular reference to human cancer." I am privileged in presenting Dr. Huggins for this prize. For his is more than a contribution to knowledge; it is an immediate gift to the welfare of man.

SCIENTIFIC NOTES AND NEWS

A TESTIMONIAL dinner to Dr. Walter S. Landis, vice-president of the American Cyanamid Company, was given on the evening of May 15 at the twenty-first annual meeting of the American Institute of Chemists. The gold medal of the institute was presented to him in recognition of his contributions to the field of chemistry. Speakers at the dinner were: Dr. Gustav Egloff, president of the institute and research director of the Universal Oil Products Company; Harry L. Derby, president of the American Cyanamid Company; and Maximilian Toch, president of Toch Brothers, Inc. Dr. Landis gave an address entitled "The Personal Service of the Chemist to the Nation."

DR. GUSTAV EGLOFF was the recipient of the Columbia University Medal of Merit for 1943, which is awarded annually to "an outstanding scientific or technological leader in industry." The medal was presented on June 1 at the convocation of the university.

L. M. PIDGEON, of the National Research Council of Canada, has been awarded the platinum medal of the International Nickel Company by the Canadian Institute of Mining and Metallurgy and the special merit medal of the Professional Institute of the Civil Service of Canada for his development of a successful method of producing metallic magnesium.

THE annual award of the President and Visitors Research Prize of the Virginia chapter of the Society of Sigma Xi this year was made at the twentieth annual meeting on May 25 to Dr. Gordon T. Whyburn for his work in the field of topology. At this meeting there were initiated two alumni, two faculty members, ten members from the Graduate Department and nineteen associates from the college, graduate and professional schools of the University of Virginia.

THE Ohio State University at its commencement exercises on June 11 will confer the doctorate of laws

[1] This address will be published in SCIENCE.

on Dr. Henry H. Goddard, professor emeritus of psychology of the university.

BOSTON UNIVERSITY on May 24 conferred the doctorate of science on Dr. Frank Howard Lahey, of Boston, founder of Lahey Clinic and chairman of the directing board of the Procurement and Assignment Service for Medical Personnel for the armed forces.

THE doctorate of laws of the Massachusetts State College at Amherst was conferred at commencement on Dr. Ralph R. Parker, director of the Rocky Mountain Laboratory of the U. S. Public Health Service. The doctorate of science was conferred on Leonard S. McLaine, Dominion entomologist of Canada.

DUKE UNIVERSITY on May 22, at its commencement exercises, conferred the honorary degree of doctor of science on Brigadier General James Stevens Simmons, director of the Preventive Medicine Division, Office of the Surgeon General, U. S. Army, and on Thomas A. Morgan, president of the Sperry Corporation.

THE honorary doctorate of engineering was conferred at the commencement exercises of Lehigh University on Dr. Per Keyser Frolich, director of the Esso Laboratories, Chemical Division, of the Standard Oil Development Company.

AT the commencement of Franklin and Marshall College the doctorate of science was conferred on Dr. James I. Hoffman, chemist of the National Bureau of Standards, and on Professor G. C. Chandlee, chairman of the department of chemistry of the Pennsylvania State College.

AT the annual meeting in New Orleans of the American Oil Chemists Society, Lamar Kishlar, St. Louis, research director for the Ralston Purina Company, was elected president for the coming year.

DR. EARL H. HERRICK, professor of zoology and mammalogist of the Agricultural Experiment Station at Kansas State College, has been awarded the Elizabeth Clay Howald scholarship of the Ohio State University. This scholarship carries a stipend of $3,000 for the year. It was established by the late Ferdinand G. Howald in memory of his mother. Dr. Herrick will devote his time to a study of vitamin E in relation to anterior pituitary function.

Nature states that officers of the Royal Astronomical Society for the ensuing year have been elected as follows: *President,* Dr. E. A. Milne, Rouse Ball professor of mathematics, University of Oxford; *Treasurer,* J. H. Reynolds; *Secretaries,* Dr. H. R. Hulme, chief assistant, Royal Observatory, Greenwich, and D. H. Sadler, superintendent of the "Nautical Almanac"; *Foreign Secretary,* Sir Arthur Eddington, Plumian professor of astronomy, Cambridge; *Council,* Miss M. G. Adam, chief assistant (astronomy), University Observatory, Oxford; Dr. E. C. Bullard, Smithson research fellow of the Royal Society; Dr. J. A. Carroll, professor of natural philosophy, University of Aberdeen; Dr. T. G. Cowling, lecturer in mathematics, University of Manchester; Dr. G. C. McVittie, reader in mathematics, University of London (King's College); Professor L. M. Milne-Thomson, professor of mathematics, Royal Naval College, Greenwich; F. J. Hargreaves, Dr. A. Hunter, Captain W. N. McClean, H. W. Newton, F. J. Sellers and W. M. Witchell.

ON the retirement of Sir Arthur Smith Woodward as president of the Paleontographical Society at the annual general meeting on April 21 he was elected an honorary member in recognition of his services to the society. Sir Arthur had been president of the society for nine years, following thirty years as secretary. During his period of secretaryship, in addition to the ordinary duties of that office, he contributed two important monographs on Cretaceous fishes to the series of volumes issued by the society, which describe and illustrate British fossils. He is succeeded as president by Professor H. L. Hawkins, professor of geology at the University of Reading.

DR. JOHN B. PARKER, for thirty years a member of the faculty of the Catholic University, Washington, has been made professor emeritus of biology.

DR. A. L. MELANDER, professor of biology and head of the department in the College of the City of New York, will retire at the close of the academic year.

DR. ROBERT G. CROSEN, associate professor of chemistry and acting dean of Lafayette College, has been appointed dean.

DR. HENRY NELSON HARKINS, since 1939 associate surgeon of the Henry Ford Hospital, Detroit, has been appointed associate professor of surgery at the Medical School of the Johns Hopkins University.

ENDING his twenty-fourth year as a member of the faculty of the Military College of South Carolina at Charleston and a teaching career of nearly half a century, Dr. Newland Farnsworth Smith, since September, 1919, head of the department of physics, will retire from active teaching at the close of the academic year. He has been given leave of absence until next September, when his resignation becomes effective. The corps of cadets paraded on May 21 in his honor and after the ceremony the commander of the regiment presented him with gifts from the cadet corps. Dr. Smith plans to take up work as a research physicist in the Philco Laboratories in Philadelphia, where his son, Newland F. Smith, Jr., has been for a number of years.

DR. W. HARRY FEINSTONE has been appointed director of biological research of the Pyridium Corporation of Yonkers, N. Y. He will be in charge of the Biological Laboratories and of development work on chemotherapeutic agents as well as on other pharmaceuticals.

THE *Journal* of the American Medical Association reports that Lieutenant Colonel Loyal Davis, professor of neurologic surgery at Northwestern University, is a member of an Anglo-American Commission to visit Russia. Since his arrival in London on September 6 of last year he has been senior consultant on neurosurgery in Europe. Another American member of the mission to Russia will be Colonel Elliott C. Cutler, of Peter Bent Brigham Hospital, Boston, and professor of surgery at Harvard Medical School. Colonel Cutler is senior consultant on general surgery to the American Expeditionary Force.

DR. GRANT L. DONNELLY, associate professor of pharmacology in the School of Medicine of the University of North Carolina, has resigned his professorship in order to resume practice in western North Carolina.

DR. BARRY G. KING has recently resigned as assistant professor of physiology at the College of Physicians and Surgeons, Columbia University. He has received a commission as lieutenant in the U. S. Naval Reserve as a physiologist assigned to medical research at the Naval Research Institute, National Naval Medical Center, Bethesda, Md.

DEAN C. J. MACKENZIE, acting president of the National Research Council of Canada, arrived in England on May 8. He planned to stay about a month and will make his headquarters with the National Research Council of Canada. Conferences will be arranged with scientific men in Great Britain on questions of scientific research connected with the war.

THE *Times*, London, states in its issue of May 6 that Professor S. A. Sarkisov, representing the executive committee of the Soviet Red Cross and Red Crescent Societies, had arrived in Great Britain to establish contact with the British Red Cross and British medical men, in order to develop mutual exchange of experience in the medical treatment of wounded and sick soldiers and in assistance to the civilian populations that have suffered as a result of the war.

PROFESSOR MARSTON T. BOGERT, of Columbia University, addressed on May 8 the annual meeting of the Columbia Chapter of Phi Lambda Upsilon. He spoke on "Malaria and Antimalarials."

THE American Society for X-Ray and Electron Diffraction will meet at the University of Michigan from June 7 to 11 under the presidency of Professor M. J. Buerger, of the Massachusetts Institute of Technology.

THE American Home Economics Association will hold a Wartime Institute at the University of Maryland with 225 delegates representing all state associations from June 18 to 21. This session has been planned in compliance with the request of the U. S. Office of Defense Transportation that all organizations "voluntarily establish travel conservation." Instead of the usual summer convention for several thousand home economists, this is to be a workshop type of meeting for a small number of persons each of whom is in a state position and in direct contact with large numbers of people. There will be a program of papers on "Strengthening the Home for War and Postwar Living." Each morning speakers from both government and non-government agencies and specialists in various fields will address the delegates; and each afternoon groups of fifteen or twenty will work together on problems of the family and on the ways in which home economists can help the family to solve those problems.

THE nineteenth Exposition of Chemical Industries will be held in New York City during the week of December 6 to 11 at Madison Square Garden instead of at the Grand Central Palace, the army having commandeered the exposition floors of the palace as an induction center. All exhibition space will be on one large floor. The actual amount of space available will be approximately half that of the 1941 exposition, which was held in the palace. A diagram of floor plans can be obtained from the International Exposition Company, 480 Lexington Avenue, New York City.

APPLICATION of arc welding to the design and construction of a jig for use in manufacture of electrical equipment, an arc welded chair and a radio tower were the respective subjects of papers for which engineering undergraduates of leading universities received the first, second and third awards in the Engineering Undergraduate Award and Scholarship Program of the James F. Lincoln Arc Welding Foundation. For a paper entitled, "Arc Welding versus Casting in the Design of Jigs and Fixtures," Herman J. Brenneke, of New York University, received the first award of $1,000 and four scholarships of $250 each were presented in his name to the department of mechanical engineering. "An Arc Welded Chair" was the subject of a paper for which Robert Edson Lee, of Iowa State College, received the second cash award of $500 and two scholarships of $250 each presented in his name to the department of architectural engineering. Application of arc welding to the design and construction of a radio tower was described in the paper for which Charles L. Sammons and John

H. Stewart, of the Ohio State University, jointly received the third cash award of $250 and a scholarship of like amount presented in their names to the department of civil engineering. In all seventy-seven awards amounting to $5,000 were made to students representing thirty-three colleges and universities.

DURING the year ended September 30, 1942, according to its annual report, the National Foundation for Infantile Paralysis received an income of $1,896,257; of which amount $1,827,345 represented net proceeds from celebrations of the President's birthday, the remaining $68,912 representing miscellaneous donations and refunds and cancellation of grants and appropriations authorized in prior years. In the same year the foundation made grants and appropriations amounting to $1,142,009, all of which, with the exception of $278,706, had been actually disbursed prior to November 30, 1942. Of the net proceeds of the 1942 Birthday Celebration, $2,099,617 was given for direct relief in communities throughout the United States.

DR. C. J. ELMORE, professor of biology at William Jewell College, Liberty, Mo., who died on May 19, 1940, bequeathed his diatom collection to the New York Botanical Garden.

THE University of Chicago has instituted the Lichtstern research assistantship in anthropology. It carries a stipend of $1,000 for nine months' work and will be filled each year in which a suitable candidate appears on nomination made by the chairman of the department of anthropology. The incumbent will devote most of his time during the year to performance of a piece of library, laboratory or field research, although he may also take one course or seminar each quarter. Applicants for the position will be asked to submit their research plans. The assistantship is supported by the Lichtstern Fund and commemorates Adolph Lichtstern, who established the fund by bequest.

FORMATION of a committee of Chicago chemists and other scientific men which hopes to uncover new sources of industrial fats and greases to salvage for war needs is announced by officials of the War Production Board, Chicago. Working with the War Production Board and the Chicago section of the American Chemical Society, the committee will promote improved and new methods of fat collecting among industries such as dairies, meat packing and margarine processing. The national goal for 1943 has been set at 500,000,000 pounds and chemists are being asked to help in the drive, which has its headquarters in Chicago.

DISCUSSION

THE MOBILIZATION OF SCIENCE

IT is to be sincerely hoped that every one concerned with the welfare of the future of science gives careful reading to the so-called "Mobilization of Science" bill presented to the Senate (S. 702) on February 11 by Senator Kilgore of West Virginia and reprinted in SCIENCE in the issue of May 7. The bill has been referred to the Committee on Military Affairs.

Every scientist professionally or otherwise engaged in scientific research, whether allied to public, private or industrial institutions or independently pursuing a field of scientific investigation, and every benefactor and patron of science must needs be affected by this bill.

The bill includes the establishment of an Office of Scientific and Technical Mobilization which shall be administered by an administrator to be appointed by the President of the United States and to serve at his pleasure, to authorize such administrator to formulate and promote scientific projects and programs, to assess scientific and technical developments with relation to the national welfare, to coordinate scientific facilities and personnel, to make and amend appropriate rules and regulations which shall have the force of law, to appropriate the sum of $200,000,000 to carry out the provisions of this proposed act and to provide maximum penalties of $5,000 and/or one year's imprisonment for certain infringements of the regulations that such an administrator may set up.

It is of course gratifying to learn in the declaration of policy of this bill that "the Congress hereby recognizes that the full development and application of the Nation's scientific and technical resources are necessary for the effective prosecution of the war and for peacetime progress and prosperity. . . ." It is less gratifying to note that "serious impediments thereto consist in the unassembled and uncoordinated state of information concerning existing scientific and technical resources; the lack of an adequate appraisal, and the unplanned and improvident training, development and use of scientific and technical personnel, resources, and facilities in relation to the national need; . . . the trend toward monopolized control of scientific and technical data and; . . . the absence of an effective federal organization to promote and coordinate . . . scientific and technical developments."

It is some two years since the organization of the National Defense Research Committee and the Office of Scientific Research and Development together with the National Roster of Scientific Personnel. The remarkable results to the war effort which have already been obtained thereby with the large expenditures of over $100,000,000 during the current year may well make one wonder as to the implications of the impedi-

ments cited. It is to be noted furthermore that the object of the bill is not solely to aid in the prosecution of the war but for "peacetime progress." If the passage of this bill were to insure not alone for the war but continuing thereafter the federal control of all science, scientists, scientific institutions and scientific funds, then perhaps a truer title for the document would be "a Bill for the Regimentation of Science." If so, then it would appear that this act if passed would effect the next to the last step in the breath-taking program of the complete socialization of our "democracy" under executive order. The last stage to take place would be the regimentation of religion were it possible to regiment the emotions.

This year celebrations are being carried on throughout the country in connection with the quadricentennial of the death of Copernicus and the publication of his epoch-making volume "De Revolutionibus Orbium Coelestium." Forgetting for the moment the three hundred years of controversy with organized religion which the promulgation of the heliocentric system of the universe engendered, one can not but wonder if Copernicus had lived in an era of government regulation of science such as is proposed whether his work would have fared better.

One has only to recall the history of science to recount a few of the outstanding scientific developments due to private enterprise and genius that undoubtedly would not have been possible under any enforced program of regimentation in science had such existed. Would any governmental administrator with a board of technical advisers politically appointed have ever sponsored the revolutionary experiments of Galileo, the doctrine of the origin of the species as advanced by Darwin or the germ theory of contagious disease and the technique of immunization developed by Pasteur? Would Morton and Warren, who with great difficulty introduced anesthesia against the prejudice of organized medicine, ever have been able to succeed in eliminating terror and pain from surgery if they also had been opposed by a board with federal authority? Would the two bicycle mechanics tinkering with gliders and flying machines ever have obtained a government subsidy for their Kitty Hawk experiments after the demonstrated failure of the Langley aeroplane which had been constructed under the Smithsonian Institution with a Congressional subsidy of $50,000? What board of experts politically appointed would have known how to evaluate these discoveries from out-of-the-way sources at the times when even colleagues and medical and scientific organizations looked askance upon the early stages of these developments?

When, in 1714, the British Government offered a prize of 20,000 pounds for a means of finding longitude at sea with an accuracy of one half of a degree, and James Harrison, a clever carpenter, in 1735 succeeded in solving the problem by the invention of the temperature compensated chronometer, would a regimented scientific body have been more speedy in the recognition of the ultimate recipient of the prize money than the British Admiralty who stalled over Harrison's invention because it was not the kind of a solution to the problem that occupied the categories of their thinking? When Federal authorities regarded the dreams of Samuel Morse as fantastic when he sought Congressional funds for the first telegraph line, would the inventor have made better progress under the investigation of such an advisory body than through his persuasive sincerity in gaining private capital?

The history of science would appear to point otherwise. Many American scientific inventions of utmost military value, notably the submarine, the airplane, aerial photography and gyro-direction finders had to be financed by other nations before federal appropriations gave our own country the advantage of the inventions.

Could the progress of science into new and unforeseen fields that has been made possible through the private capital and foresight of Carnegie and Rockefeller, neither of whom was tutored in the technicalities of science, have succeeded equally well under a government-controlled board having a like sum of money at its disposal? Fortunately or unfortunately genius is a strange plant in the economy of nature. One can not foresee the territories in which the germs of genius may sprout, nor can one produce the plant of genius by the mere application either of fertilizer or of the pruning knife. It is significant that many of the major discoveries of science have been made by individuals and not by organizations of science or scientists.

Very essential for the progress of scientific thought and development is freedom for the exercise of individual initiative. To have large funds at one's disposal for the furtherance of these ideas is, of course, to be highly desired, but what assurance exists that any politically created federal agency should have the uncanny perspective for evaluating initiative and enterprise except in terms of the categories then existing. Certainly the confusion that has arisen in Washington in our present-time "managed economy" and in the control of prices and man power is not sufficiently convincing to foster the belief that a federal administration of science would work more effectively.

The first attempt to institute a federal scientific advisory body for the benefit of national welfare was the creation of the National Academy of Sciences by President Lincoln in 1863 at the time of a national emergency.

At the beginning of World War I and at the request of President Wilson the National Research Council was established to act as an advisory body in scientific matters pertaining to the national emergency.

It is to be emphasized that in the executive order this Research Council was "to survey the larger possibilities of science, to formulate comprehensive projects of research and to develop effective means of utilizing the scientific and technical resources of the country for dealing with these projects. To promote cooperation in research at home and abroad in order to secure concentration of effort, minimize duplication and stimulate progress; but in all cooperative undertakings to give encouragement to individual initiative as fundamentally important to the advancement of science."

With the inauguration of the New Deal administration under President Roosevelt a new kind of national emergency existed and a Science Advisory Board was called into being to implement the functions of the National Research Council and to advise the government relative to the administration of its scientific bureaus. It was noteworthy that most of the recommendations made by this advisory board as to specific questions raised by the government were acted upon favorably. However, additional recommendations initiated by this Science Advisory Board, though of far-reaching significance especially as concerning government bureaus of science, were not acted upon.

With the imminence of threatened hostilities the Science Advisory Board was rendered obsolete by the creation of a new organization, the National Defense Research Committee, for the complete organization and coordination of all scientific interests in the country in the interests of total war. This was done by executive order of President Roosevelt. This organization later became subordinated to a newly created Office of Scientific Research and Development directly responsible to the Chief Executive. What assurance is there that another newly created Office of Scientific and Technical Mobilization may be anticipated to be more successful than the collection of scientific advisory boards that they have supplanted.

It is certainly to be hoped that Senate Bill 702 will be given serious consideration by the scientists and scientific societies of the country not alone for its national but for its international implications. Unless those most concerned in maintaining conditions for the future progress of science give heed, it is not unthinkable that such a bill could be passed through the ignorance or lack of action on the part of those supposedly most intelligent in evaluating it. One may be tolerant of centralization of science during a war emergency, but when projected into a peacetime economy such centralized power may not only be inefficient but extravagant of public funds and may seriously jeopardize our international cooperation in science.

One is concerned in the preamble of this bill that so little recognition is given for the many well-known and effective scientific agencies that already foster and promote the welfare of science not only nationally but internationally, and that have deliberately made for the free exchange of ideas and the dissemination of information to the public. Every taxpayer should be made to understand the full implications of this bill before increasing the load of government expenditures by $200,000,000 plus for the beginning of an organization that in the end could well defeat the very purpose for which the mobilization of science act was proposed.

Unfortunately, apparently, it is not possible with present methods of bookkeeping to evaluate the cooperative scientific research of individuals, institutions and private capital which has been placed unstintingly at the disposal of the National Defense Research Committee in the interests of the war; but it is obvious that the total dollar value of salaried research men and laboratory equipment which has been freely placed at the government's disposal would render the $200,000,000 appropriation asked for in the Kilgore Bill, for the complete centralization of the science of the nation, wholly inadequate for the accomplishment of an equivalent effort.

The most significant new proposal of the Kilgore Bill not included in the executive order creating the National Research Council is "to make, amend, and rescind appropriate rules and regulations . . . which shall have the force and effect of law."

Moreover, it is to be observed that the proponents of this bill request Congress to pass a law that shall transfer their law-making power so far as it concerns the future of science to an unknown administrator without offering the benefit of knowledge of the kind of laws that such an administrator proposes to set up.

HARLAN T. STETSON

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THE OPPOSITION TO THE KILGORE BILL

THE two articles opposing the Kilgore Science Mobilization Bill which appear in SCIENCE for May 14, 1943, are certain to arouse widespread criticism. In particular, the article by the director of research of the Universal Oil Products Corporation, Dr. Gustav Egloff, who is also president of the American Institute of Chemists, contains statements so misleading as to require immediate correction. It is certainly not true that "over 95 per cent. of our scientific and technical manpower and facilities are now highly organized and coordinated to the single end of advancing the war effort." The statement that "practically every laboratory in the nation is in the service of the government"

is patently false. One has only to point to the thousands of biologists of all kinds, of geologists, mathematicians and other scientists whose work has no immediate relation to the war;[1] and to the many laboratories which are operating as usual without reference to either the war or the government. And is it true that "there are no secrets in the oil industry for the duration"?

Scientists should consider what the motives are which impel a representative of one of the great oil corporations to such gross exaggeration. Is it concern for the public good or for corporation profit? Dr. Egloff on other occasions has expressed his vigorous opposition to the Kilgore Bill in still less measured language[2] and it is evident that his fears are aroused by section 7—"Protection of the public interest in discoveries and developments financed by the United States"—which declares that property rights in discoveries made with public funds are to be vested in the public, and providing for just compensation to the discoverer. This seems to strike at the basis of private monopoly control based on exclusive private patent rights. If there are to be no secrets in the oil industry for the duration, it ought for the duration to withdraw its opposition to the legal recognition of such a lesser degree of pooling as is provided in the Kilgore Bill.

As for the opinion of the directors of the American Chemical Society that the bill would "confer totalitarian powers," one can only urge unbiased scientists to read the bill for themselves and to reach their own conclusions on this question.

L. C. DUNN

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CLASS DISTINCTION AMONG AMERICAN MEN OF SCIENCE

IN a recent issue of SCIENCE, Professor S. O. Mast[1] objects to the designation of some one thousand "leading men of science" by a star in the forthcoming edition of the Biographical Directory of American Men of Science.

I object first to the manner of his objection, which seems more suited to a political squib than to a scientific periodical. He introduces the phrase "class distinction" with its logical denotation, but uses it to draw conclusions prejudiced by its political connotation.

I object secondly to the general principle which he puts forward in the name of "democracy," *viz.*, "There should be no fixed differentiation into classes in any group of individuals without the sanction of that group." I set up against this the principle of jurisprudence, "No one should be judged in his own case." I therefore suggest that Professor Mast's suggestion that "the continuation of 'starring' of scientists in the directory be put to a vote of those involved" should not be followed—unless among those "involved" be included all who use the directory or have an interest in its use as well as those whose names are included in it.

I maintain that democracy implies a vote of the whole people, and that Professor Mast's thesis leads to a negation of democracy, namely, syndicalism (against which *I* am prejudiced).

L. H. THOMAS

THE OHIO STATE UNIVERSITY

[1] Nicholas, J. S., 1942, "The War Problem of Manpower in Biology and Agriculture," *American Scientists*, Vol. 30, pp. 297–298, estimates that in the biological sciences alone exclusive of medicine, there are available about 67,000 scientists. The National Roster of Scientific and Professional Personnel contains the names of thousands more not involved in war work.

[2] Egloff, Gustav, 1943, "Scientific, Technical, Inventive and Industrial Mobilization for War," address at the meeting of American Institute of Chemists, Washington, D. C., March 13, 1943. Scientists should also consult the evidence concerning Dr. Egloff's statements and opinions which were attacked by Judge Arnold and published in "Hearing on S 702 United States Senate," part 1, March 30, 1943, especially pages 9 and 17.

[1] S. O. Mast, SCIENCE, 97: 465, 1943.

IS CORRECT LABELLING UNDEMOCRATIC?[1]

Mast, S. O., Ph.D. Johns Hopkins University, Baltimore, Md. Professor of Zoology. In Charge General Physiology, Johns Hopkins University. (1).

SUCH is the description to be found in the Federation Year Book, and to those searching for simple data, it is an admirably succinct label. That such statements quite clearly put The Doctor Professor Chairman Mast of Johns Hopkins University into a most exclusive class, not only amidst some half-million of his local fellow beings, but also in the entire world, is true. In spite of much levity, Ph.D.'s are not yet as common as blackberries and men capable of holding such positions as the above are very scarce. Moreover, to say there is but one Johns Hopkins is a statement of fact.

Consequently, the recent attempt of Dr. Mast to view a matter of simple grading through the curiously wrought lens of a political belief seems rather needless. Indeed, as seen through other glasses in common use in a nearby city, this attempt to remove useful data from a label might be considered false and misleading!

Technical labels have nothing to do with democracy nor any other political pattern, as I feel sure that Professor Mast experimentally rediscovers each time he corrects his examination papers. Nor would it seem really in the interest of science to decrease in any way our efforts quantitatively to estimate everything

[1] "Class Distinction among American Men of Science," SCIENCE, 97: 2525, May 21, 1943.

measurable, even our own abilities. That it should be snobbish to use such grading seems hardly tenable in an age when fruit, vegetables, pigs, meat, fish, flowers, drugs, chemicals and especially incomes are so treated. Why should distinguished professors or scientists expect to be excluded? It is not democratic!

O. S. GIBBS

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SCIENTIFIC BOOKS

RELATIVITY

An Introduction to the Theory of Relativity. By PETER GABRIEL BERGMANN. xvi + 287 pp. New York: Prentice-Hall, Inc., 1942. $4.50.

THE book aims to present the theory of relativity to students of physics and mathematics who have had no previous introduction to the subject. The material has been divided into three parts: the special theory of relativity, the general theory and a report on unified field theories.

We will confess that had we no previous knowledge of the theory of relativity we should find great difficulty in following the book. This results not so much from any fundamental difficulty in the subject itself as from the uncertainty concerning the degree of sophistication which one must adopt in interpreting the meaning of things at certain stages. Only by drawing upon his previous experience in this matter and by supplementing the material of the book by much interpretation and clarification drawn from his former thinking is the reader able to find the happy medium appropriate to the spirit of the book, and lying between the two extremes of a superficial attitude and a super-critical one.

Thus, on page 11, the reader may wonder what is intended to be meant by force in a statement which implies that the consistency of the ratio force to acceleration is a law of nature other than a definition. Referring to the introduction of relativistic electrodynamics in Chapter 7, one who has thought deeply on the subject would find it difficult to understand what is meant by the truth of Maxwell's field equations without supplementation by a force equation.

The foregoing illustrations are simply samples of many places in which one without additional background would find difficulcy in fixing in his mind the matter of what is definition and what is experimental fact or assumed law of nature. However, such difficulties must inevitably arise in any book which attempts to cover a wide field in a relatively limited space, and the work will undoubtedly be found to be of considerable value to those who, having some acquaintance with the subject, desire a standard of reference; and it will be of great value to those who are able to read it under conditions in which there is at hand somebody who has thought deeply on the subject and is able to interpret to them such uncertainties as may arise.

The fact that the book has a foreword by the father of relativity, Albert Einstein, naturally enhances its value and dignity.

W. F. G. SWANN

BARTOL RESEARCH FOUNDATION OF THE FRANKLIN INSTITUTE

MICROBIOLOGY

Microbiology and Man. By JORGEN BIRKELAND. New York City: F. S. Crofts and Company. 478 pp. 35 figs. $4.00.

THE past ten or fifteen years have seen a remarkable development of popular interest in microbiology with a corresponding increase in the number of academic or non-technical students who take a course in bacteriology as a "cultural" subject. A large proportion of these choose this subject not so much from any curiosity concerning the nature of bacteria as from a curiosity, sometimes almost morbid, concerning disease. One can barely keep them awake when lecturing on the morphology and physiology and classification of bacteria, but can hold them spellbound when describing the symptoms of rabies. It is for such students that this book has been written.

The pragmatic approach to the subject is indicated by the title and by the first statement in the preface—"the proper study of mankind is man." To the reviewer it still seems that the proper study of the student of microbiology is the microbe, but he realizes that in this he is somewhat out of fashion.

In Dr. Birkeland's book emphasis is placed upon the effects of bacteria upon man, and while industrial or agricultural relations are mentioned here and there, mainly the book is concerned with bacteria in relation to human disease. An introductory portion of 130 pages considers the morphology and physiology of bacteria; the chapters on sterilization and disinfection are especially complete. A second section (50 pages) is concerned with general principles of infection and immunity, including epidemiology. A third section (184 pages) describes some of the more important infectious diseases and the organisms which cause them. Such details as age, racial and seasonal incidence; history; mode of spread and means of prevention, are gone into rather thoroughly. A fourth section (77 pages) deals with the microbiology of food, milk, water, sewage and soils, again with major emphasis on disease prevention. An appendix presents an outline of the classification of bacteria according to the latest edition of Bergey's Manual, a glossary of technical terms, and a list of references to various general and special works on microbiology.

So much space is devoted to descriptions of diseases and to what should properly be considered hygiene rather than bacteriology that much of the subject-matter of microbiology has been omitted or treated very scantily. Such important groups as the anaerobes, the spirochaetes, the Actinomycetes and the autotrophic bacteria are barely mentioned, but there is a discussion of the per capita cost of soap in relation to hardness of water! One may question whether it is desirable to devote so much of the time of a supposedly cultural course to public health, especially when so many students now take college courses in preventive medicine. Such a presentation gives the student a very one-sided picture of microbiology, as though its relation to disease were its sole *raison d'être*.

For such teachers as wish to place the emphasis where this book places it, Dr. Birkeland's text can be recommended. It is very readable, enlivened here and there by bits of verse and anecdote, with much history of disease and sanitation. The reviewer was particularly tickled by the recommendation that the student apply the principle of Koch's postulates to political problems. The style is clear and straightforward, the arrangement orderly. It should be a very easy book to study. The presentation is rather elementary, but in this respect the book is somewhat uneven. Thus the student is not expected to know anything about the structure of a cell, but is expected to know enough chemistry to follow the conversion of tryptophane to scatole and indole.

The teacher who uses this text-book will need to supplement it with a very complete laboratory manual, for it gives little of the technique of the bacteriologist. Particularly, there is not much discussion of the procedures by which species of bacteria are identified or distinguished. Here again the treatment is somewhat uneven. The student is told, for instance, how to distinguish caprine, porcine and bovine strains of *Brucella*, but not how to separate *Escherichia coli* from *Aerobacter aerogenes*. However, such deficiencies can be readily made up in an adequate laboratory course.

ARTHUR T. HENRICI

SOCIETIES AND MEETINGS

NORTH CAROLINA ACADEMY OF SCIENCE

THE forty-second meeting of the North Carolina Academy of Science was held at Duke University on April 30 and May 1. Approximately eighty papers were presented in addition to two symposia related to the war. The first symposium was on "Health and the War," the second on "Nutrition in War Time." The meeting was exceptionally well attended in spite of war restrictions and proved interesting and profitable to the membership. About forty-five new members were added to the roll, and a number of former members were reinstated after a lapse of several years of non-membership.

The following officers were elected: *President,* M. L. Braun, Catawba College; *Vice-President,* Mary E. Yarborough, Meredith College; *New Member of the Executive Committee,* E. H. Hall, of the Woman's College of the University of North Carolina. Bert Cunningham, of Duke University, continues as secretary. Section officers elected are:

Section	*Chairman*	*Secretary*
Botany	F. A. Wolf	E. C. Cocke
Geology	W. F. Prouty	Willard Berry
Physics	W. E. Speas	N. Rosen
Psychology	Elizabeth Duffy	K. Zener
Wild Life	John D. Findley	R. O. Stevens
Zoology	G. T. Hargitt	Eva G. Campbell
Biochemistry	H. W. Ferrill	J. C. Andrews

H. S. Perry was selected to receive the Poteat Award for his noteworthy paper on "Control of Starchy Contamination in Sweet Corn by the Use of the 'Gamete' Gene."

Two awards were made to high-school students—one to Robert Anderson for his essay entitled "Fire in the American Forests" and the other to Donald Hartzog for his exhibition in photography, which included portrait enlargements, stills and microphotographs.

The academy selected State College at Raleigh as the next meeting place.

From the standpoints of interest, attendance and worth of papers, this meeting is considered by many members to be one of the best the academy has had.

BERT CUNNINGHAM, *Secretary*

KENTUCKY ACADEMY OF SCIENCE

THE thirtieth annual meeting of the Kentucky Academy of Science was held at the University of Louisville, April 23 and 24, in five divisional meetings and two general sessions. Affiliated groups represented were Biology, Kentucky Branch, Society of American Bacteriologists and Kentucky Society of Natural History, in joint session; Chemistry; Geology; Psychology and Philosophy; Physics, Astronomy and Mathematics, in joint session. Forty-two papers were read including that of the president, Dr. J. T. Skinner, on "Some Functions of Mineral Elements in Connection with Enzymatic Action," before the

Academy in general session. At the annual dinner at the Seelbach Hotel, Herman F. Willkie, of Jos. E. Seagram and Sons, spoke on "Alcohol Goes to War."

In addition to their divisional meetings the Kentucky Geological Society and the Kentucky Society of Natural History conducted field trips in the Louisville area. The latter society became an affiliate of the Academy.

The grants for aid in research of the American Association for the Advancement of Science were awarded to W. R. Allen and to D. R. Lincicome, both of the University of Kentucky. Officers elected for 1943–1944 are as follows:

President, L. A. Brown, Transylvania College.

Vice-President, Paul J. Kolachov, Jos. E. Seagram and Sons.

Secretary, Alfred Brauer, University of Kentucky.

Treasurer, Wm. J. Moore, Eastern Kentucky State Teachers College.

Representative on Council of American Association for the Advancement of Science, Austin R. Middleton, University of Louisville.

Councilor to Junior Academy, Anna A. Schnieb, Eastern Kentucky State Teachers College.

ALFRED BRAUER
Secretary

SPECIAL ARTICLES

THE "VITAMIN M" FACTOR[1]

EARLIER studies by Langston and associates[2] have demonstrated that monkeys which were maintained on diet 600, a modification of the Goldberger diet 268, developed nutritional cytopenia. This deficient diet supplemented with either 2 g of liver extract or 10 g of dried brewer's yeast daily maintained nutritional balance in monkeys. However, the basic diet supplemented with nicotinic acid, riboflavin and thiamine failed to alter appreciably the course of the deficiency manifestations. The term "vitamin M" was proposed for this factor present in liver and yeast which prevents nutritional cytopenia in the monkey. The identification and chemical isolation of additional members of the vitamin B complex suggested to us a study of whether diets supplemented more fully by the other members of the complex would simulate the activity of vitamin M, in preventing nutritional disequilibrium.

Methods and materials. Healthy young adult *Macaca mulatta* were employed in these studies. Three diets were used (Table I). A basic diet free of members of the vitamin B complex was substituted for the 600 diet, since the vitamin content could thereby be more accurately and easily controlled. Diet 1 consisted of the basic diet supplemented with 5 members of the B complex; diet 2 contained 5 other members of the complex in addition to diet 1; and the control diet 3 was made up of the basic diet supplemented with 2 cc of crude liver extract. All the supplements were dissolved in water and administered by means of a stomach tube every other day, except the liver extract which was introduced subcutaneously every other day.

TABLE I

EXPERIMENTAL DIETS

Diet 1
Basic diet

	Per cent.
Sucrose	68
Casein	18
Vegetable oil	8
Salt mixture U.S.P. number 2	4
Cod liver oil U.S.P.	2

Vitamin supplements:

	Daily rations mg
Thiamine hydrochloride	1
Riboflavin	1
Pyridoxin hydrochloride	1
Nicotinic acid amide	25
Calcium pantothenate	3
Ascorbic acid	25

Diet 2
Diet 1 with addition of:

	Daily ration mg
Choline chloride	50
Pimelic acid	1
Glutamine	1
Inositol	1
Sodium paraminobenzoate	50

Diet 3—Control
Basic diet plus 2 cc of liver extract every other day.

Results. All 6 of the monkeys on diet 1 and all 22 monkeys on diet 2 showed progressive weight loss, followed by lethargy, dryness of the coat and finally anorexia and weakness. Minor degrees of gingivitis appeared in about half the monkeys on both diets between the 21st and 44th diet days. As previously reported,[3] the animals on these dietary régimes developed leukopenia between the 4th and 15th weeks and displayed lowered resistance to experimental and spontaneous infections.[4] Significant degrees of anemia developed in less than half of the animals on diets 1 and 2.

Three monkeys each received limited supplements of a yeast residue containing folic acid.[5] They showed marked leucopoietic and clinical remissions during brief experimental periods.

Four monkeys on the control diet, supplemented with liver extract, exhibited none of the deficiency symptoms, in direct contrast to the other monkeys on the experimental diets, and gained weight and were in excellent health over a 6-month experimental period.

[1] This work has been aided by a grant from the International Health Division of the Rockefeller Foundation. Constituents of the special diets were generously furnished by the S.M.A. Corporation.

[2] W. C. Langston, W. J. Darby, C. F. Shukers and P. L. Day, *Jour. Exp. Med.*, 68: 923, 1938.

[3] H. E. Wilson, C. A. Doan, S. Saslaw and J. L. Schwab, *Proc. Soc. Exp. Biol. and Med.*, 50: 341, 1942.

[4] S. Saslaw, J. L. Schwab, O. C. Woolpert and H. E. Wilson, in press.

[5] B. L. Hutchings, N. Bohoros, W. H. Peterson, *Jour. Biol. Chem.*, 141: 521, 1941.

Summary. The factor included in liver extract ("vitamin M") which is responsible for maintaining nutritional and hematopoietic equilibrium in monkeys is (1) apparently not identified with the following constituents as at present isolated: riboflavin, thiamin, nicotinic acid, pantothenic acid, glutamine, pimelic acid, choline, sodium paraminobenzoate, inositol and pyridoxin; or (2) if it is any of these factors, the combined administration of the above respective fractions did not result in the effect obtained with liver extract when given by the parenteral route (hypothetical "M" factor).

The administration of a yeast residue, containing, among other unknown elements, folic acid, more closely simulated the effect of parenteral liver extract than any other material we have thus far had the opportunity to test.

Liberal amounts of the basic diet and fresh water were kept in the cages at all times. The supplements were suspended in water and fed by stomach tube except liver extract which was administered subcutaneously. Diet and supplements were supplied by the S. M. A. Corporation.

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INOSITOL A TUMOR GROWTH INHIBITOR

THE importance of inositol for normal growth was established by the investigations of Eastcott,[1] Woolley[2] and others. There are no reports to date on the influence of inositol on malignant growth.

In this communication we describe the results of experiments dealing with the action of inositol on tumor growth. For these studies a rapid test for tumor growth inhibitors was employed.[3] In this test the inhibition of tumor growth is judged by comparing tumor sizes and tumor weights of treated groups of mice with untreated ones in an experimental period of 48 hours.

In Table 1 a series of experiments is presented, in which varying doses of inositol were studied. From this table it is evident that intravenous injections of inositol inhibit tumor growth, the degree of inhibition depending on the dose injected. Since September, 1942, inositol in varying doses was used in 16 experiments on 400 animals with the corresponding number of controls. The results of these experiments were similar to those presented in Table 1.

TABLE 1

EFFECT ON TUMOR GROWTH OF FOUR INTRAVENOUS INJECTIONS OF INOSITOL IN VARYING DOSES GIVEN OVER A PERIOD OF 48 HOURS*

Group No.	No. of animals in each group	Dose of Inositol γ	Mean terminal tumor weight mg	Standard error
453	11	0 (control: saline)	470	25.6
452	18	38	436	22.8
451	14	50	350	33.6
450	10	75	270	34.1
449	7	100	246	41.1
448	5	150	215	26.4
447	5	250	222	9.8
446	5	1000	142	12.8

*Female Rockland mice transplanted with Sarcoma 180; start of the experiment 8 days after transplantation; mice kept on polished rice diet for the experimental period of 48 hours.

Subcutaneous or oral administration of inositol was ineffective. Equally ineffective were intravenous injections of l-inositol,[4] inosose,[4] crystalline factors of the vitamin B-complex (thiamine, riboflavin, pyridoxine, nicotinamide, pantothenic acid, p-aminobenzoic acid, biotin and choline). Sodium phytate[4] and lipositol[4,5] showed an inhibition similar to that of inositol.

CONCLUSIONS

Inositol was found to inhibit tumor growth. The degree of inhibition depends on the dose injected. Inositol, a pure crystalline substance, can be used as a standard of reference for testing tumor growth inhibitory factors.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

NEW OBJECTIVE METHOD FOR THE DETERMINATION OF THE CIRCULATION TIME

THE determination of the circulation time in animals and human beings has generally been associated with certain disadvantages. The various tests which require subjective cooperation on the part of the patient are open to many criticisms. Some of the disadvantages are evident in the case of children, deaf mutes, moronic or mentally sluggish individuals and

[1] E. V. Eastcott, *Jour. Phys. Chem.*, 32: 1096, 1928.
[2] D. W. Woolley, SCIENCE, 92: 384, 1940; *Jour. Biol. Chem.*, 139: 29, 1941.
[3] D. Laszlo and C. Leuchtenberger, Cancer Research, 1943. To be published.

[4] We are indebted to Dr. D. W. Woolley, of the Rockefeller Institute, New York, for generously supplying us with these substances.
[5] D. W. Woolley, *Jour. Biol. Chem.*, 147: 581, 1943.

those in stupor and coma. The intravenous injection of ether, saccharin or sodium dehydrocholate carry with them not only disadvantages but even dangers.

Occasionally, some subjects whose taste buds are not fully developed may not respond in the desired measure. For that reason, objective tests have been greatly sought. These have ranged from the use of sodium cyanide, histamine, 50 per cent. carbon dioxide, alpha-lobeline ether and, more recently, the use of fluorescein. These drugs are reported to produce objective results, but, as is the case with sodium cyanide, are often open to danger. Calcium gluconate can not be used in cardiac cases that have received digitalis therapy without serious complications.

The danger of complications following the intravenous injection of many of these substances is obviated by a new objective method we have devised. This method is based on the principle that light transmitted through various translucent tissues of the body, such as the ear, finger or toe tips, or flexible skin anywhere on the body (such as that over the calves of the legs, the arm pit or the skin web between the thumb and index finger), can be detected by means of a sensitive photoelectric cell.

The injection of certain non-toxic dyes, intravenously, such as 2 to 4 cc of a 1 per cent. solution of methylene blue, or 1.0 cc of phenol-sulphon-phthalein, acts as a temporary curtain to impede the transmission of light. Interference with the transmission of light by the dye can be observed by the deflection of the indicator of a sensitive galvanometer, connected with the photoelectric cell. The time elapsing between the injection of such a dye into the vein of the arm or leg and its arrival to the point where the light and photoelectric cell have been placed, can be determined by a stop-watch, or can even be recorded objectively, by connecting the leads from the photoelectric cell to a recording galvanometer.

Thus, an objective record determination of the circulation time is made possible, which no other method affords. The fluorescein method, the safest objective method to date, is open to the criticism that several individuals may not note it at the same time. The thickness of the skin or mucous membrane and its blood content may also modify the time of fluorescent visualization. The use of a dye with a light and photoelectric cell set-up, is not only of value in determining the circulation time, but also can be used for the determination of the time required for the blood to be cleared, as demonstrated by the return of the galvanometer needle to its pre-injection point. The determination of the circulation time is recognized today to be of value in differentiating thyrotoxicosis and cardiac decompensation from other conditions which may be confused with them.

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CONTRACTION OF DENERVATED MUSCLE PRODUCED BY d-TUBOCURARINE

FROM a consideration of the physico-chemical properties and especially the polarographic behavior of the alkaloid obtained from *Chondodendron Tomentosum* (d-Tubocurarine), and other quaternary ammonium bases having high reduction potentials, it seemed very probable that the rapid intra-arterial injection of this alkaloid would cause contraction of denervated muscles. This was shown to be true for dog-gastrocnemius denervated ten days previously. A strong contraction followed the close intra-arterial injection of d-Tubocurarine. The contraction was followed by partial relaxation and terminated by a long contracture which persisted for approximately thirty minutes. During the contracture and for a considerable time after the muscle was found to be unresponsive to previously effective quantities of intra-arterially injected acetylcholine. Direct stimulation of the muscle provoked contraction during the period of curarine-induced contracture. Full details of the experiments and a discussion of their significance will be published later.

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